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TELEGRAPH FINANCE.

IT sometimes happens that great zeal is a quality which acts more for the benefit of others than for the good of its possessor. The so-called "financial scandal" affords us an illustration of this. It is Mr. Scudamore who has made the telegraph what we find it to be. His energy, zeal, and wonderful ingenuity have procured us a system of wires which approaches perfection, and which, considering its youth, promises to be the most complex and best worked of all the land telegraphs in the world. But this very zeal which has urged him on, and whose results have entitled him to the nation's gratitude, has betrayed him into an "irregularity," the commission of which, being discovered, has constituted a "scandal."

Though much can be said on the condemnatory side of the question, and arguments of much weight brought against that part of the matter which involves the accounts of the Savings' Bank, even more can be said on the defensive view of the subject. In this world energy and zeal are merely potential, without funds. Mr. Scudamore has been so placed as to be especially in need of them. He is rearing a great, gauky system, with a very large appetite, and outgrowing its old clothes. Parliament is slow and not always sure,—it is a case for prompt action,—there is the money, idle, and at hand; it will not be misused, it will be known all about at a not very distant period, it will all be made good, and it is wanted now—at once. An irregular proceeding, certainly. Enough to make a scandal of, with very careful management of the materials it supplies. No one, however, can say that the money has been misused. Every penny of it has been spent for the public good, and, moreover, for a lasting good. A scandal is a creature of a session, and, if born early in the season, is as likely as not to be a shaky old invalid in July. But the telegraph will outlive all of us—M.P.'s, Journalists, and all. Of what moment will be the "irregularity" and the "scandal" of to-day, when our telegraph-keys shall be busily worked and the needles shall wag for posterity. The *Spectator* says that, as far as *taking* the money is concerned, it is a mere question of account, and that it is no more the Savings' Bank that suffers than any one of the sources of revenue. And in this view we are inclined to concur.

As is so often the case in matters of this kind, the system is mainly at fault. It may be more proper to say the absence of system. The occurrence, however, from whatever cause arising, affords an additional instance of the exceptional position of the Post-Office considered as one of the governmental departments. For the Post-Office is a mysterious branch of the service. The Admiralty was in the same way once upon a time, but we were at length told all about its internal red-tape squabbles and its phantom board. The Post-Office has till now succeeded in remaining involved in obscurity: has its turn come for basking in the light of day? But if the Post-Office is mysterious, the Telegraph is almost inquisitorial in its working, quite apart from the necessary privacy as to the intelligence with which it has to deal. This is, of course, partly owing to the fact that the whole department of the Telegraph, as a subdivision of the Post-Office, is so entirely new. No doubt, when it is in thorough working order, when the system has developed to its final extensions, we shall be no longer in the dark as to its *modus operandi;* a periodical report will be published, after the manner, say, of the Board of Trade, and the department will then lose its inquisitorial aspect.

While it happens that the circumstances are such as to make Mr. Scudamore the prominent individual in this affair, it is pretty evident that he has only a share of whatever blame there may be. The Treasury, for example, appears to have greatly neglected its duty in remaining passive while the irregular proceedings were going on. The investigation will show how much the Treasury is answerable for, and whether or no Mr. Scudamore is to blame at all. That there is no moral guilt in the question no one would deny, even if it is certain that he is officially culpable. Be this as it may, we do not think another man could be found who is equal to the work for which Mr. Scudamore is so well suited. For though he may find the trammels of officialism a drag upon his individual energy, there is yet both need of his organising capacity and scope for his skill as a director. No mere official cleverness would answer the purpose as well. He seems to combine considerable engineering power to his other talents, enabling him to perceive the scientific bearing of the question in addition to its ministerial aspect. Thus to lose such a man as Mr. Scudamore would be a real calamity; and we trust that, however irregular his recent conduct may be deemed, the general appreciation of his invaluable services will ensure his continuance in the post which he has so efficiently filled.

THE last list issued by the Indo-European Company shows an average time taken in transit between here and Calcutta of 1 hour 40 minutes, Bombay of 1 hour 36 minutes, and other places in India of 1 hour 46 minutes.

A SYSTEM OF MAGNETO-ELECTRIC CLOCKS.

In any building in which a number of clocks are required, it is impossible to keep them synchronously at work, if they are of the ordinary construction, having separate regulators and separate maintaining powers. To remedy this evil, various systems of electric clocks, either maintained or regulated by the action of galvanic currents, have been suggested and tried; but they have all practically failed, principally by reason of the oxidation of the contacts at those points where the circuit is periodically interrupted.

A system of magneto-electric clocks has been designed by Sir Charles Wheatstone so as to be effectually free from this objection. The maintaining power is supplied by magneto-electric currents developed in a coil of wire attached to the pendulum, and made to oscillate over the poles of permanent magnets. Each indicating clock is actuated by an astatic system of magnetic needles kept in continued rotation by these magneto-electric currents, and the motion of these needles is communicated through a suitable train of wheelwork to the hands. In this way the whole wire circuit remains unbroken, and the currents are alternately inverted without any making and remaking of contacts (which are the chief source of failure of the electric system) being employed. A single motor on this principle will actuate sixty or seventy indicating clocks in the same circuit.

The accompanying illustrations will fully explain

Fig. 1.

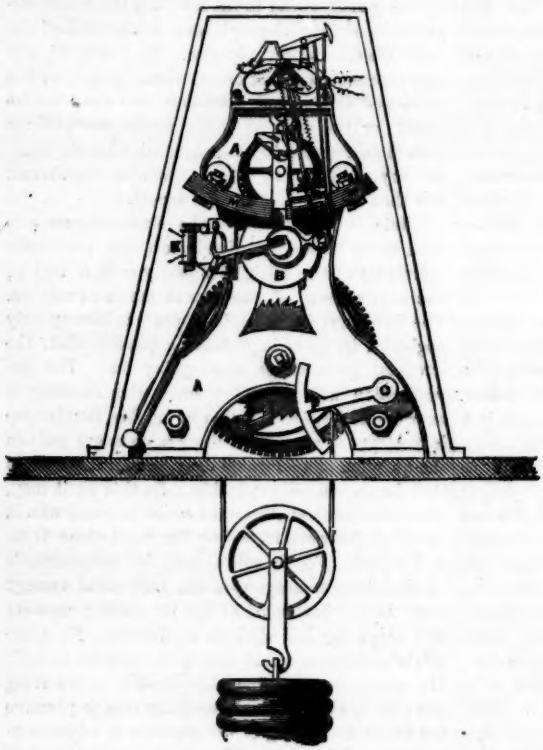


Fig. 2.

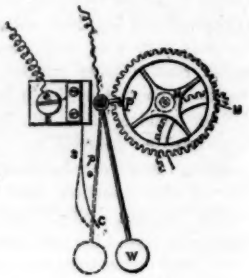
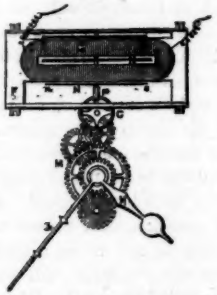


Fig. 3.



the detail of the working arrangements. Fig. 1 is a front elevation of the motor or driving-clock, which consists of a strong clockwork movement, suppor ted by the iron frame, A A, and maintained by the weight, W. The escapement of this clock moves the pendulum, P, the "bob" of which (a coil of fine insulated copper wire) passes at each beat over the poles of two magnets, M M. When this motor is regulated by a standard or astronomical clock, the regulation is effected by raising or lowering the centre of gravity of the pendulum, P, by means of a ball kept swinging with the pendulum, and the position of which is altered by the end of a lever, which, when released, falls upon the inclines of a notch in the disc D, which rotates once in two hours.

Fig. 2 shows the arrangement by which the regulating current is given by a standard clock. The pin p', on the wheel M, raises the shorter arm of a bell-crank lever, which carries a weight, W, until it releases it, when the lever swings and makes contact with the spring, C, thereby closing the circuit of a battery, and of the electro-magnet, E, Fig. 1.

Fig. 3 shows the internal mechanism of the indicating clocks. It consists of a coil of wire, G, with an astatic system of needles, on the axis of which is a pinion, P, gearing into the wheelwork, C M, which moves the hands, H h. The wire of the coil, G, is connected by means of insulated wires with the coil of the pendulum-bob, P (Fig. 1), in an unbroken metallic circuit.

A system of these clocks is at present working in the Royal Institution,* in the University of London at Burlington House, and at the International Exhibition.

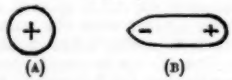
ON THE TERMS "TENSION," "INTENSITY," AND "QUANTITY."

By W. E. AYRTON, Professor of Natural Philosophy, the Government Engineering College, Japan, and Corr. Sec. Soc. Tel. Eng.

THESE words are daily employed by the majority of those engaged in Telegraphy, and to their use may be attributed, I think, the great want of accuracy in electrical matters displayed by many of this class of men. Nothing is more likely to foster unscientific habits of thought than the constant employment of ill-defined terms.

Undoubtedly, in many cases, these words convey a definite meaning to those who use them, but unfortunately the signification attached to any one of these terms by different people, or even, I regret to say, by the same person at different times, is not always the same. For instance, if an insulated

FIG. 4.



positively charged body (A) be brought near to another insulated conductor (B), as in Fig. 4, some writers say that the tension at the two ends of (B) is the same in amount and in sign, others that it is different, the fact being that the first mean, by tension, potential,—the second, by tension, electric density. If a wire in connection with the earth be attached to any point of (B), the current that will flow through this wire will be the same, no matter which point of (B) is selected. It is quite true, therefore, to say that the potential of every point of (B) is the same. But if now a proof plane be applied to different parts successively of the surface of (B), and the small charges that are taken away on the plane tested, these will, of course, be found to be different, as they will be positive when the proof plane is applied towards the right end of (B), negative towards the left end, and zero at about the centre. The electric density, therefore, on the surface of (B) varies from point to point; consequently both sets of writers are correct, although their statements are apparently contradictory; but I need scarcely point out that such statements are well calculated to lead to confusion.

Many other instances of a similar kind can be adduced to show that the use of the word "Tension" is exceedingly objectionable, and should be carefully avoided by all electricians, as has been done unanimously by the British Association, the words "Potential," "Electric Density," "Resultant Force," with their clearly defined meanings, being used instead.

We will next speak of the words "Intensity," and "Quantity." These are generally employed when dealing with batteries and galvanometers, as an Intensity- or Quantity-battery, and an Intensity- or Quantity-galvanometer. An Intensity-battery is the name for one that will send a strong current through a large external resistance. Its own electromotive force must, therefore, be large; consequently an Intensity-battery merely means one with a high electromotive force. By a Quantity-battery is meant one which for its electromotive force will send a strong current through a small external resistance. Such a battery must, therefore, itself have a small internal resistance; consequently a Quantity-battery is simply synonymous with small internal resistance. But if a so-called Quantity-battery be used on a circuit of large external resistance the quantity of current that will flow will be very small, unless the electromotive force be itself very large. In this case, therefore, the so-called Quantity-battery gives very little quantity of current; consequently the name "Quantity," as applied to batteries, is quite unscientific. But, unfortunately, the employment of these terms has given rise to two others still more useless and confusing, namely, Intensity- and Quantity-current. A constant current is quite defined if we know its strength and what may be called its direction. The words "Intensity" and "Quantity," therefore, as applied to currents, convey no further information. The popular expressions that a current has not sufficient Intensity, or that it has not sufficient Quantity, for some particular purpose, both only mean that the Strength of the current—which is the quantity of electricity passing per unit of time—is not large enough.

Among French writers Intensity *of* current and among English writers Quantity *of* current are often used synonymously with Strength of current. To use three expressions for the same thing is objectionable, as it tends to suggest three distinct properties, but it is not nearly as bad as speaking, as is commonly done, of Intensity- and Quantity-currents as if such currents differed in kind, and not simply in strength. Such names are quite unscientific, and have, I am certain, led to considerable confusion. The expression "Intensity *of* current" can, as Sir Wm. Thomson has pointed out, be well employed as follows:—If a uniform current be flowing through a conductor of varying thickness, the quantity passing per unit of area of section of conductor will be different at different points, being greatest where the conductor is thinnest, and least where the conductor is thickest. Now the quantity of current flowing across per unit of area of conductor at any point may be well expressed by the "Intensity of the Current" at that point. Obviously this employment of the word "Intensity" is quite distinct from the way it is used by ordinary writers.

By an Intensity-galvanometer is meant one of high resistance,—that is, one on which a so-called Intensity-battery will give a considerable deflection for its internal resistance. And a Quantity-galvanometer is the name given to one of small resistance,—that is, one on which a so-called Quantity-

* A system of these clocks was generously presented to the Royal Institution a few months since by Sir Charles Wheatstone.—ED. T. J. AND E. R.

battery will give a considerable deflection for its electromotive force; but what is gained by calling a high-resistance galvanometer an Intensity-galvanometer, and a low-resistance galvanometer a Quantity-galvanometer, I am at a loss to conceive.

Another expression one also frequently hears is to test a battery for Intensity and Quantity, when what is really meant is to test its electromotive force and internal resistance. To compare the electromotive force of a battery from day to day one of course uses a comparatively high-resistance galvanometer, because with such an instrument the deflections will not be affected by slight alterations of the battery-resistance, but only by variations of the electromotive force; and to make periodic comparisons of the resistance of a battery a low-resistance galvanometer is made use of, since the deflections on such an instrument are much affected by alterations of the battery-resistance. It would, therefore, be more rational, and certainly more useful for beginners in electricity, if the two coils of a battery-testing galvanometer were called respectively the "Electromotive force" and the "Internal resistance coils," instead of, as at present, the "Intensity" and "Quantity" coils.

From what I have said it will be seen, first, that the names Intensity- and Quantity-battery, and Intensity- and Quantity-Galvanometer, mean undoubtedly four distinct things, but are very bad names for expressing the differences. Secondly, that the expression Intensity- and Quantity-currents mean nothing more than is already expressed by the strength of a current. Thirdly, that the Intensity and Quantity of a battery mean usually two distinct things, while the intensity and Quantity *of* a current are generally employed to express exactly the same thing. Fourthly, that in a conductor of varying thickness there is a property varying at different points of the conductor, and to which no name is commonly given, but which, as Sir Wm. Thomson has suggested, could well be expressed by the "Intensity of the Current at each point."

It would therefore be extremely advisable that Intensity and Quantity should never be used in connection with batteries or galvanometers, that Intensity in connection with currents should be limited to the use suggested for it by Sir Wm. Thomson, and that Quantity should be employed solely with reference to a quantity of electricity; also that the quantity of electricity passing the section of a conductor per unit of time should *only* be called the Strength of Current, or simply the Current.

ELECTRO-CAPILLARY CONSTANT CURRENT PILES.

By M. BECQUEREL.

I HAVE given much attention to the subject of constant current piles since the year 1823, at which time there were none of the data necessary for their establishment. I presented several memoirs on this subject to the Academy of Sciences, and I constructed the first sulphate of copper and nitric acid piles, which I used for the reproduction of mineral substances. The porous diaphragm was merely a plate of pulverised kaolin; this was afterwards replaced by cylinders of half-baked and porous porcelain, which have since been generally used in constant current piles.

When I had discovered the principle of electro-capillary actions,—by which they cause, in the fissures of substances, the reduction of the greater part of the metals, and the production of different insoluble crystallised bodies analogous to those found in Nature,—I sought to apply it to the construction of electro-capillary constant current couples. I made many attempts before I attained the end I intended, in order to avoid counter-currents.

The fundamental principle on which electro-capillary actions depend is the property which the liquids adhering to the surfaces of the bodies, in the capillary spaces, possess of conducting electricity, as do metals and other solid conductors, in the same time that they are decomposed. The consequence of this property is, that when two solutions—one, for instance, of nitrate of copper, the other of monosulphuret of sodium—are found in contact in a capillary space which separates them, such as in a crack in glass, it produces an electric current along the partition in such a direction that the part in contact with the solution of the monosulphuret is the positive electrode, the other the negative electrode. This direction is inverse to that of the current which would occur if the space were not capillary, and the two solutions communicated together by means of a wire or a plate of platinum. This inversion of the current plays one of the principal parts in electro-capillary couples on account that it considerably diminishes the counter-currents. In the electro-capillary couple the deposit of copper is effected on the side of the fissure in contact with the solution of the nitrate; the current produced has great energy, for the resistance that it experiences is very feeble, it having to travel over only an exceedingly short length of liquid.

It is possible to construct two different couples that give the same result. The first couple consists of a glass test-tube containing a concentrated solution of monosulphuret of sodium, in which is plunged a cracked tube filled with a solution of sulphate or nitrate of copper; afterwards another tube was used, having at its base a plug of kaolin. In each of the two metallic solutions was plunged a plate of copper, which was put in communication with a wire of the same metal. There were two currents produced: in the cracked tube the electro-capillary current went from the metallic solution to the monosulphuret; in the second, the current took its rise in the plug during the reaction of the nitrate on the monosulphuret, following the same direction as the first, and adding to the reducing action of the electro-capillary current in the crack. The extremity of the plate of copper which was inserted in the plugged tube is the negative pole where the copper is deposited; the extremity of the other plate is the positive pole, which, in oxidising, renders the current constant when the solutions are maintained at the maximum of concentration. In uniting several similar couples by the poles of contrary name, we form an electro-capillary battery; with three or four couples water can be decomposed by means of two platinum plates. We shall study presently the properties of this battery.

We consider in a battery the electromotive force and the resistance. For the determination of the

electromotive force we have used a pile with amalgamated zinc and sulphate of zinc, cadmium and sulphate of cadmium. It has been found that; taking for unity the electromotive force of this couple, that that of the nitric acid couple is evidently equal to five times its force; that of a sulphate of copper couple, three times; finally, the electromotive force of the electro-capillary couple. to 2½ times; so that these three forces are nearly in the relation of 20, 12, 9; also that the electromotive force of the electro-capillary couple is three-fourths that of a sulphate of copper couple, and nearly half that of a nitric acid couple.

We now come to the second couple, which is more simple than the preceding, and which has the advantage of putting in evidence the causes of the electricity produced in the several parts of which it is formed. We take a test-glass filled with a saturated solution of nitrate of copper, into which we introduce a cracked tube containing a solution of an alkaline monosulphuret, and in this a tube filled with a solution of nitrate of copper; we apply to the exterior of the fissure of the cracked tube a very fine and very narrow band of copper, pierced here and there with little holes, *vis-à-vis* to the crack, so as to facilitate the access of the nitrate solution to that part. This plate is bound on the surface of the tube with a wire of the same metal wound in a spiral. We introduce into the plugged tube a plate of copper, which is put in communication with the wire of the same metal which surrounds the small plate of copper. Immediately, copper is deposited in the crack by the electro-capillary action, and finds itself in contact with the covering; it then acts only as a metallic arc traversed by the current produced in the plugged tube resulting from the action of the nitrate on the monosulphuret by the intervention of the kaolin plug. The two extremities of the metallic arc are covered with the reduced metallic copper, and yet if we pass the current through a galvanometer we see that the two extremities of the metallic covered with copper furnish to the current, the one positive electricity, the other negative electricity. The positive electrode is the end of the plate plunged in the plugged tube, and the negative electrode the extremity of the deposit of the copper in the crack which is in contact with the monosulphuret.

This last reacts upon the metal, whence results sulphide of copper, which is immediately decomposed by the electro-capillary current, with deposit of copper, which gradually increases, forming little protuberances. The plate and the copper-wire are covered equally with copper, because they are in contact with the copper of the crack, or rather are prolonged by it: it results from this that we cannot perceive which is the positive electrode. During the electro-capillary decomposition of the sulphide of copper, the sulphur gives itself to the monosulphuret solution, where it forms a polysulphuret, recognisable by its yellow colour; in consequence of this reaction the copper of the fissure and of the plate constitute the negative pole of an electro-capillary couple. In the couple that we are describing there was no current produced, whilst there was a deposit of copper in the fissure; the other current is then, so to speak, independent of the first.

The effects produced in the couples, of which we have given the description, are easily explained as follows:—The sides of the fissures being conductors of electricity, the current goes from the plugged tube into the fissure by the monosulphuret solution and by that of the nitrate; this direction is the same as that of the electro-capillary current, the action of which is augmented. From what precedes, we see that in electro-capillary couples the plates and wires of copper serve only to establish communication between the several parts of which they are composed. The production of electricity, and consequently of the current, is due to the reaction of nitrate of copper on the monosulphuret in the plug, and to that of the monosulphuret on the copper deposited in the fissure giving place to a production of sulphide of copper, which is decomposed immediately by the electro-capillary current, this current following the same direction as the first, and causing its inversion. All the effects of which we speak cease when the fissure is not capillary,—that is to say, when the copper deposited there becomes widened; in this case there are two currents, in contrary directions, which neutralise each other.

Further, I will describe another capillary couple possessing great energy, and producing at the same time crystallised metallic sulphides, namely, the sulphides of silver, copper, antimony, lead, &c. This couple is formed of a test-glass containing a solution of monosulphuret, in which is plunged two tubes not cracked, open at the two ends, one of which is plugged with kaolin, the tube containing a solution of nitrate of copper and a plate of the same metal or of platinum or carbon. The other tube is also plugged at the inferior extremity, but with a band of paper wound very tightly around a cylinder, half of copper, half of a metal attackable by the monosulphuret; the copper part is in the interior of the tube and plunged in the nitrate, the other metallic portion in the monosulphuret; the plate of copper of the plugged tube and the part of the cylinder of the same metal are put in communication by a metallic wire.

Following this arrangement, the couple produces two currents in the same direction: the first takes its rise in the plug of kaolin; it enters the copper plate placed beneath (which is the negative electrode), then passes to the composite cylinder, the lower end of which plunged in the monosulphuret is the positive electrode. This is the second source of electricity: the current which it produces acts partly as an electro-capillary and partly as an ordinary current in the same direction as the first. The electro-capillary current exercises its chemical action in the paper plug very strongly. The portion of the plug on the side of the nitrate is filled with reduced copper, and the other side and the cylinder plunged in the monosulphuret are covered with crystals of metallic sulphide.

These couples can form a battery as in the preceding cases. An electro-capillary couple which permits of diminishing the resistance is composed as follows:—We take seven simple couples, each surrounded with a small plate of copper; we group six around one in such a manner that all the coppers are in contact. These seven couples are introduced into a beaker containing a solution of nitrate of copper. All the conductors of the same metal which surround the exterior of the cracked tubes are put in communication, the tubes being filled with solution of an alkaline monosulphuret. There is adapted to the exterior envelope of all the

couples a metallic wire; this wire receives negative electricity, and the central wire, to which is attached the wires of the plugged tubes, carries positive electricity. I have not yet experimented with this battery.

The couples already employed have an electromotive force for each one equivalent to three-fourths of that of a sulphate of copper couple; they present a very high resistance, so that it is better to unite the couples in quantity rather than in tension. It is found that the chemical action is great. The cracks cannot be replaced by porous diaphragms such as those in general use, for the reason that the latter are not sufficiently capillary.

In a future memoir I shall enter into details as to the means of augmenting the energy of electro-capillary piles.

ON A METHOD OF TESTING LENGTHS OF HIGHLY-INSULATED WIRE.*

By Professor FLEEMING JENKIN, F.R.S.

THE object of the present paper is to describe a method of testing the insulation of submarine cables with Sir William Thomson's Quadrant Electrometer.

The plan is a simple and convenient modification made by Sir William on the arrangement he has previously used, and the system has been introduced by him in concert with myself for the tests of the Great Western Telegraph Company's Cables, and more lately for the cable of the Platino-Braziliera Telegraph Company. The method has been found so convenient in practice that, although it contains no very striking novelty, I hope that it may interest the Society.

It is well known that the insulation resistance of a cable can be measured by observing on the electrometer the gradual fall of potential, occurring when the conductor, after having been charged by a voltaic battery, has been disconnected from the battery and left in connection with one quadrant of the electrometer, the other quadrant being to earth.

Let R be the insulation resistance in megohms; S the capacity of the conductor in microfarads; P the potential to which the battery employed charges the conductor (in any units); p the potential to which the conductor falls in any time t expressed in seconds; then it is well known that—

$$R = \frac{0{\cdot}4343\, t}{S \log \frac{P}{p}}$$

and in this equation we may write for P and p, the simple deflections of the quadrant electrometer. This method has the very serious defect, that with high insulation resistances, the differences between P and p are extremely small, unless t be made inconveniently great, and even when the fall of potential occurs somewhat rapidly, the accuracy of the test is not very satisfactory, being limited by the accuracy with which the difference of the deflections can be read, this difference being necessarily only a fraction of the whole length of the scale.

The modification now to be described has the effect of increasing the delicacy and accuracy of the test. This is effected by virtually prolonging the scale so that the deflections are not counted from any visible mark on the scale, but from what may be called the *inferred zero*, an imaginary point which may be many thousand divisions to the right or left of the actual scale. The whole potentials, P and p, are then represented by thousands of divisions instead of hundreds, the fall is measured in hundreds instead of in tens, and by a proper choice of the inferred zero, may be made for each class of cable to extend over nearly the whole length of the actual scale.

One quadrant is permanently connected with one pole of a battery, the other pole of which is to earth.

The second quadrant is connected with the conductor of the cable to be tested, and is charged along with the conductor to the same potential as the first quadrant by a short contact with the same pole of the same battery. When this short contact is first broken, the two quadrants are at the same potential. The potential of the quadrant connected with the cable will fall, in consequence of the leakage through the insulating sheath of the cable, but the potential of the second quadrant will remain unchanged during the experiment; the spot of light will move from its first undeflected position, which I will term the actual zero, towards one end of the scale. Let us assume the sensibility of the electrometer to be such that one cell would give a deflection of 100 divisions, and that we charge the cable with 100 cells; then as soon as the potential has fallen 1 per cent we shall observe a deflection of 100 divisions on the scale; by the time the potential has fallen 4 per cent we shall have a deflection of 400 divisions. What is termed the "inferred zero" is the final reading which we should obtain if the cable and its quadrant were wholly discharged while the other quadrant remained fully discharged to the maximum potential. Clearly this, in our example, would be 10,000; the inferred zero cannot be directly observed, but is obtained with greater accuracy by using resistance coils to subdivide the potential of the battery. The two poles of the battery are constantly joined through a high resistance with convenient subdivisions; the electrometer reading given by any convenient fraction of the maximum potential is thus obtained in a well-known manner, and the inferred zero is given by a simple multiplication.

The diagram shows the connections actually employed.

The battery, C Z (frequently 100 cells), is connected direct to the cross-bars of an ordinary reversing key, A, the springs of which are joined to the extreme ends of the slide, C H, C being also connected to earth.

An ordinary set of resistance coils may be used instead of the slide.

The resistance used should be sufficiently great not to diminish sensibly the full difference of potentials that the battery can produce.

The movable contact of the slides is connected to one bar of the second reversing key, B, the other cross-bar being connected at N to the distributor D. This consists of six or eight brass terminals, L, well insulated on vulcanite pillars, arranged in the arc of a circle. The cables to be tested are connected to these terminals, which are tipped with platinum; contact can be made with any of them by the movable arm K, which is also tipped with platinum.

* Read before the Society of Telegraph Engineers.

The object of the distributor is to allow several cables to be tested simultaneously.

The springs of the key, B, are joined to a short-circuiting piece, F, which again is joined to the two electrodes of the electrometer, which must be well insulated.

The electrometer scales are divided into half millimetres, and numbered from zero to one thousand, beginning at the left hand side. The actual zero of the electrometer is arranged to be at or near the zero of the scale, and the fall of potential is observed always in the same direction, the readings increasing from zero as the charge in the cable diminishes. When the battery is reversed by the key, A, the second reversing key, B, reverses the electrometer also. The inferred zero is the limit to which the readings on the electrometer tend as the cable discharges, and is equal to the value of the battery in scale divisions, if the electrometer starts from zero on the scale. To find the inferred zero the movable contact, M, is placed so that there is one-tenth of the whole resistance of the slide between G and M. One of the springs of the key, A, is depressed, and also the corresponding one of key B. The short-circuiting plug is removed, and the distributor turned on to the last terminal, T, which is in connection with the earth. The deflection thus obtained multiplied by ten gives the distance in millimetres of the *inferred* zero from the *actual* zero reading. The inferred zero having been found the arm, K, of the distributor is removed from the terminal, T, the contact, M, moved up to H, and the short-circuiting plug inserted. The cable to be tested is attached to one of the terminals, L, and is now connected with the battery by the arm, K, which will be seen by the diagram to be in connection with H (and consequently C or Z) through the short-circuiting plug at F. This battery contact is maintained sufficiently long to establish electric equilibrium throughout the cable, 15 seconds being enough in general. After this time the plug in the short-circuiting piece, F, is removed, leaving the cable in connection, through the distributor and key, B, with one electrode of the electrometer.

The potential of the cable now begins to fall, while the electrode of the electrometer not in connection with the cable is maintained at the full potential of the battery by connection with H; hence the difference between the electrometer reading (at any time) and the inferred zero gives the potential of the cable in scale divisions at that time.

The difference of logarithms of any two of these values of the potential of the cable gives a definite measure of the quality of the insulating material, independently of the length of the cable, and the actual insulation is given by the above formula.

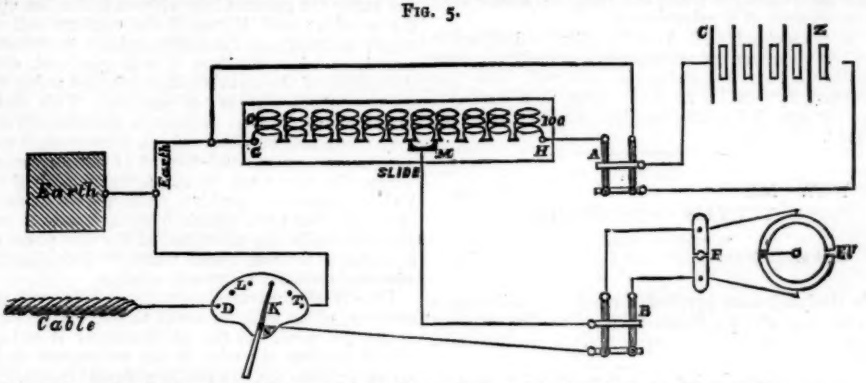
To find the insulation resistance after two minutes' electrification, readings are taken at 1′ 45″ and 2′ 15″ after the battery is first applied to the cable. These readings are subtracted from the inferred zero, and the logarithms of the difference taken.

A constant—

$$\frac{0{\cdot}4343\ t}{S}$$

divided by the difference of the two logarithms thus found, gives the insulation resistance in megohms.

Fig. 5.



Example, Hooper's material at 75° F.—

Actual electrometer zero	100
Reading with tenth B	650
Difference	550
Difference multiplied by ten	5500
Electrometer zero	100
Inferred zero	5600

Time.	Reading.	Diff. from inferred zero.	Log.	Diff. of log.
1′ 45″	354	5246	71983	—
2′ 15″	395	5235	71642	00341

$$\text{Constant} = 30 \frac{30}{0{\cdot}43} \frac{0{\cdot}4343}{} = 30{\cdot}3.$$

$$R = \frac{30{\cdot}3}{0{\cdot}00341} = 8890 \text{ megohms per knot.}$$

The advantages of this mode of testing, as compared with the common electrometer, are increased delicacy and accuracy, as has been explaind already.

The delicacy of the test may be increased *ad libitum*, by increasing the electromotive force of the battery, the sensitiveness of the instrument, and the length of time, *t*.

When compared with any galvanometric method it has other advantages. The absence of any magnet in the electrometer allows the test to be made while machinery is in motion. Currents which from various causes are induced in the cable, causing

irregular deflections on the galvanometer, are unperceived on the electrometer. Short coils of high insulation resistance, which would show no sensible leakage on the galvanometer, are easily tested by the new system, and last not least several coils or cables can be tested at one time with a saving of labour. The distributor is used for this purpose. One coil is attached to each terminal; each coil is electrified in succession, and then detached from the quadrant until a few seconds before the reading is required. In this way long tests of electrification can be made on, say five coils in one-fifth of the time required for galvanometer tests. At Millwall we have in this manner tested three cables at one time, obtaining a complete separate series of tests for each cable. The labour of reducing the tests to resistance per knot is small, and the inferred zero of the electrometer is much less liable to change than the constant of a galvanometer.

I am indebted to Mr. Wm. King for the description of the details of the arrangement actually in use at Millwall. Mr. Bottomley, at Millwall, finds that (testing two cables at once) there is a saving of 38 per cent in the time required for the tests of the tanks.

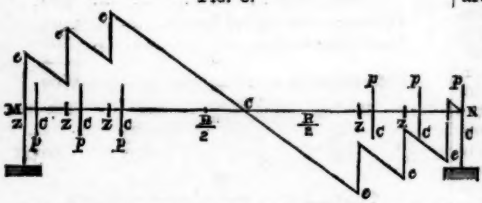
NEW METHOD OF DETERMINING VOLTAIC CONSTANTS.

By EMILE LACOINE,
Chief of the Technical Division of the Ottoman Telegraphs.

In studying some particular cases of tensions in a permanent circuit, I have been led to the use of a new method for the comparison of electromotive forces.

When a conductor is traversed by a current maintained by two equal batteries at each extremity, as in practice on most railways, we observe that the tension is distributed as shown in the following figure:—

Fig. 6.



The inspection of this figure, and the discussion of the general formulæ of cases of tension, show that there exists an intermediate point, c, where the tension is *nil*.

The general formula is—

$$t = T + I\varepsilon r - \varepsilon e,$$

where t = tension at the point considered,
T = tension at the origin,
I = intensity of the current in the circuit,
εr = resistance of the circuit between the point considered and the origin,
εe = the sum of the electromotive forces between the point considered and the origin,
ρ = the resistance of an element,
R = the total resistance of the circuit without battery.

By supposing, as in the figure, six elements, and making—

$$T = 0, \varepsilon e = 3e, r = 3\rho + \frac{R}{2}$$

and—

$$I = \frac{6e}{6\rho + R},$$

we have—

$$t = \frac{6e}{6\rho + R} \times \frac{6\rho + R}{2} - 3e = 0$$

for the tension of the point c.

Consequently, if we put this point, c, of the line in communication with the earth, the tensions do not change, and it follows that, on a line where the current is continuous, the middle is the part which can suffer the greatest loss without indication upon the needles; and, if one of the stations call the other, the needle of the station calling is deflected exactly as when the line is well insulated, while the needle of the station called does not move, and the operator is unaware of any loss. This distribution of the tensions explains a phenomenon that may sometimes be observed on lines worked with continuous currents and formed of non-galvanised wires; for, as we see in the figure, a part of the line possesses a positive tension and tends to oxidise in this part, especially at the points of suspension, whilst the other part of the line possesses a negative tension, which tends to deoxidise the wire and maintain its proper relation.

Finally, the intermediate point, *c*, being put into communication with the earth through a galvanometer, the needle of the galvanometer is not deflected, because the wire of the instrument is inserted between the two points without tension.

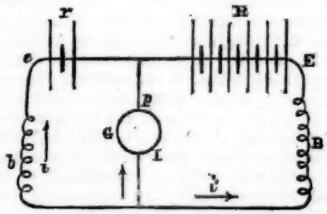
Although the position of the point, *c*, varies with the electromotive forces of the batteries and the intermediate resistance, we can always, in the case of two batteries of which the poles of contrary name are united, find an intermediate point where the tension is *nil;* inversely, the position of this point being known, we can determine the relation of the electromotive forces.

It is this which constitutes the base of the method in question, which we can comprehend more easily still by the aid of the laws of Kirchhoff and the accompanying figure (Fig. 7).

In effect, the batteries being arranged as shown in the figure, Kirchhoff's laws give—

$$i = I + i',$$
$$i(r + b) + I\rho = e,$$
$$i'(R + B) - i\rho = E.$$

Fig. 7.



In order that the galvanometer shall not be

traversed by any currents, it is necessary to put $I=0$; then $i=i'$, whence we obtain—

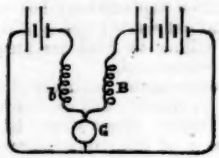
$$ir=e$$
$$ir'=E$$

whence—

$$E=e\frac{R+B}{r+b} \quad (1).$$

We can obtain the relation of the electromotive forces independently of the resistance of the

Fig. 8.



batteries, which we can neglect in the case where B and b are very great in relation to R and r, when we shall have—

$$E=e\frac{B}{b}.$$

In the case where we cannot neglect the resistance of the batteries, we can repeat a second experiment,

This method, which I believe to be new, furnishes the relation of the electromotive forces under a form more simple than that of Poggendorff; similarly, it is independent of polarisation, and admits of rapidity in operation.

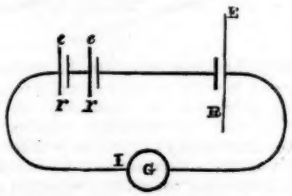
In practice we can arrange the connections as shown in the figure (Fig. 8); and taking for b a resistance of 110, and for b' a resistance of 10, we can obtain the relation of the electromotive forces by simple subtraction, for we have—

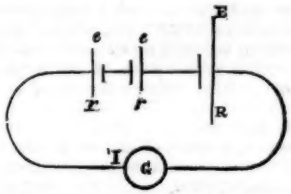
$$\frac{E}{e}=\frac{B-B'}{100}.$$

I have yet to make known two other practical processes for the comparison of batteries, which do not need resistance bobbins.

The method of Wiedemann is simple, and this simplicity causes it to be much employed by those who have no resistance coils at their disposal; but for many reasons it is not convenient, for we obtain too wide differences with it when measuring batteries having nearly the same electromotive force. In effect, if we take a galvanometer of slight sensitiveness, we cannot measure the difference of the intensities, and if it is too sensible, we cannot measure the sum of the intensities, the deviation being too strong. I work in the following manner with the aid of a sensitive galvanometer:—I take two elements to be tried in the place of one, and I

Fig. 9.





modifying the exterior resistances, so as to obtain equilibrium in the galvanometer; we have then—

$$E=e\frac{R+B'}{r+b'} \quad (2).$$

With the equations (1) and (2), eliminating R and r, we have—

$$\frac{E}{e}=\frac{B-B'}{b-b'} \quad (3).$$

and this formula gives the relation of the electromotive forces independently of the resistance of the batteries.

couple them with the standard element, in two different ways, as indicated in the figures (Fig. 9).

In the first case we have—

$$I=\frac{2e-E}{2r+R+G}.$$

In the second case we have—

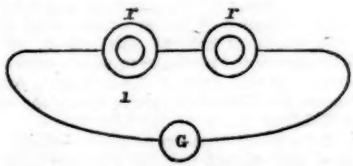
$$I'=\frac{E}{2r+R+G},$$

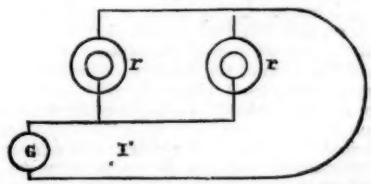
whence we infer—

$$\frac{E}{e}=\frac{2I'}{I+I'},$$

independently of all artificial resistance.

Fig. 10.





The same two formulæ (1) and (2) admit also of the obtaining of the value of the resistance of one pile as a function of the other. We have in this case—

$$R=\frac{B(r+b')-B'(r+b)}{b-b'}.$$

We see, then, in the two cases the effects are not very different if the elements are of nearly the same force.

This process gives the comparison of the standard with the mean of two elements to be tested, and this is sufficient for practical purposes.

We can also arrive at a knowledge of the mean resistance of elements without resistance coils by the aid of a galvanometer of known resistance by proceeding as indicated in the figures (Fig. 10).

In the first case we have—

$$I=\frac{2E}{2r+G}.$$

In the second case—

$$I'=\frac{E}{\frac{r}{2}+G}$$

whence we infer—

$$r=G\frac{2I'-I}{2I-I'}.$$

These last two processes are not theoretically perfect, but they are convenient and useful in practice where test-instruments are not at hand.

AN IMPROVED MORSE APPARATUS.

We have received from M. Otto Bucheim, Chief Engineer of the Railway Telegraphs of Kursk-Charcow-Azow, an account of a wheel which he thinks will prevent the inconvenience of the rupture of the spring of the clockwork in the Morse apparatus. The rupture of the chain or spring in the Morse apparatus is a fact occurring very frequently. In the system with weights the repairing of the chain is easy, and from the solid construction the rupture occurs but seldom. But when a spring is broken reparation becomes much more difficult, for by its rupture four or five teeth of the large wheel follow *en suite*, and the axle of the wheel is sometimes twisted or bent. The repair can then be perfectly effected only in a good workshop. M. Bucheim does not profess, of course, to prevent the rupture of the spring, but he reduces materially the ill effects of the rupture.

When the spring breaks it produces evidently a very violent rebound, but this rebound should not cause damage to the wheels in the immediate neighbourhood of the spring; and damage may be prevented by instantly arresting the motion of the spring. The method by which M. Bucheim attains this end consists in fixing behind the large wheel—which in the Morse apparatus constructed by Messrs. Siemens has always 134 teeth—a second wheel, called the "safety-wheel." This wheel is a little smaller than the first, and is fixed to it by means of three screws. This wheel, at the moment of the rebound, is instantly arrested by a click. It should be set very strongly, and constructed always of hard brass. If the safety-wheel has as many teeth as the principal wheel—that is, 134—it is clear that, in the case of the rupture of the spring, one of the teeth of the principal wheel must suffer atleast severe strain before the click fastens on the stop- or safety-wheel. It has been ascertained, by experiment, that 252 teeth upon the stop-wheel are sufficient,—that is to say, under the least favourable circumstances when the click acts upon the stop-wheel, the principal wheel will have completed a movement equal to $\frac{1}{252}=0{\cdot}53$ of a tooth.

The system has been applied to several Morse instruments, with which a series of experiments have been made with satisfactory results. The stop-wheel can of course be added to any construction of Morse instrument.

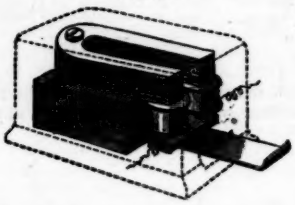
ON SIR CHARLES WHEATSTONE'S ELECTRO-MAGNETIC COUNTERS.

By THOMAS T. P. BRUCE WARREN,
Electrician to Hooper's Telegraph Works, Limited.

An interesting article on these useful instruments appeared in the first number of this Journal. It is with the view of supplementing this paper with my experience that I presume to offer the following remarks upon them. What is said, generally, of their action is sufficiently clear and exhaustive as to require no further explanation; but what I wish to do is to point out a few cases in which the instrument, from failing to fulfil its purpose, may be prematurely condemned.

A simple experiment will more clearly illustrate what I have to convey, and on this account I will preface my further observations by reference to Diagram No. 1 of the paper referred to, which is subjoined.

Fig. 11.



When the lever carrying the armature is suddenly and forcibly pressed down, a momentary current is produced, and similarly, on releasing the lever so that the armature regains its position, another momentary current is produced.

This forms a very interesting experiment, when the two terminal wires are connected with an ordinary "detector," in showing the opposite character of the induced currents produced on breaking and making contacts, as in taking off and replacing the armature.

Now if the armature be very carefully and slowly removed the "detector" will not be affected, nor will it be affected if the same be made to return slowly to the poles of the magnet. We must not consider, because the needle of the "detector" is not deflected, that no current is produced; for if a more sensitive galvanometer be employed, the same phenomena may be observed as with the "detector" in the previous experiment.

From these experiments it is evident, when registering the number of the revolutions of a wheel, that if the releasing of the armature takes place slowly the shock or current will not be strong enough to actuate the mechanism which moves the pinion-wheel in the train of the indicator, and if the armature be allowed to return slowly the same result will follow.

It so far appears that up to a certain limit the strength of the current induced will vary with the force and suddenness with which the armature is pulled away, and conversely when regaining its position.

In Fig. 3 of the paper referred to a method is given of fixing the lever to a machine, but if the motion of the wheel be slow we involve the conditions already pointed out. To attach multiplying

gear is not only expensive, but in most cases impracticable.

The simplest method of getting over this is to fix a small steel pin in the rim of the wheel, near its edge, where we gain the velocity required to

FIG. 12.

make the contacts more suddenly and forcibly. The length of time between the contacts necessary to register one complete indication is perfectly immaterial, so that should the wheel stop after the armature has been pushed off, and we get the first current only, the second follows immediately after the wheel or pin clears the lever.

The attachment as shown in the Diagram No. 3 will do very well with a machine driven at a high speed, or even at a tolerably quick rate, neither of which is the case with the measuring-wheel of a cable-making machine.

Another precaution worth pointing out is, that the lever should be withdrawn without giving rise to any liability from the acting power to produce any serious vibration or jarring as to allow the lever to leave its position after the completion of one indication.

If an auxiliary lever be employed a strong spring should be attached to the arm nearest to the pin, which will completely settle the shivering motion which might be communicated to the armature and its lever.

As two or more indicators may be driven by the same set of magnets, these instruments would be extremely useful in cases where it is wished to convey the indications to two or more places at the same time.

ITALIAN TELEGRAPHY.—The Italian Chambers have approved a project for laying down a submarine telegraph line between Brindisi and Egypt.

MR. WILLOUGHBY SMITH has written a letter to *Nature*, in which he says that vitreous selenium may be considered a non-conductor of electricity. It is only when in a crystalline condition that it becomes a conductor. A bar now in his possession, 2·25 × 0·5 × 0·05in., tested with an electromotive force of one-tenth of a Daniell's cell, gives a deflection of 140 divisions on the scale of an ordinary astatic mirror galvanometer. The same deflection produced under the same conditions through a known resistance shows the resistance of the selenium to be 360,000 ohms. By the well-known Bridge system the resistance of the same plate of selenium is 359,500 ohms, the two different tests thus confirming each other. If selenium be exposed to the direct rays of the sun, it gradually becomes crystalline. May not the explanation of the phenomenon be found in this fact?

Electro-Physiology.

DR. RADCLIFFE'S POSITIVE CHARGE.

To Dr. Radcliffe is due the application of a most simple and equally efficient method of electrisation. This application consists in imparting to the patient a charge of *positive* voltaic electricity, the patient and battery being both insulated, and the negative pole being connected to "earth" through a gas- or water-pipe. The patient, to whom is attached the positive pole of the battery, thus becomes charged with positive electricity. Both battery and patient may be conveniently insulated upon a sheet of gutta-percha, about 4 feet square by ¼ an inch to ⅜ of an inch in thickness. Dr. Radcliffe's investigations lead him to the conclusion that the primary condition of animal electricity is not current, but static. The muscular and nervous state during rest is that of charge, and in the case of action, of discharge. Experiments made with the view to ascertain the conductivity of the sarcolemma have resulted in defining its action as that of a dielectric. This happens also with the neurolemma. On the outer surface of the sarcolemma or neurolemma is developed, by the molecular action of the blood, positive electricity, and the dielectric action of their sheaths causes the induction of negative electricity upon the interior surface, similarly to the charging of a Leyden jar. This has led Dr. Radcliffe to his particular theory of muscular action,—that the elongation of muscular fibre is caused by the elastic sarcolemma being compressed at right angles to its length by the mutual attraction of the opposite electric charges disposed upon its surfaces; and this theory he supports by exact experiment. The action of discharge of the electricity would consequently cause contraction of the muscular fibre by releasing the sheath from the cross compression. Nerve fibres, or rather their sheaths, are subjected to the same pressure of the two opposite electricities, but the elongation upon discharge does not follow, because they are less elastic than muscular fibre. The current theory of Du Bois-Raymond, all the electrical phenomena of muscle and nerve, are explained by Dr. Radcliffe's theory. From the view taken it may be supposed, in consequence of the non-conductivity of the sheaths of muscles and nerves, that an artificial charge would affect them in the same manner as does the natural charge; that is, if the exterior surface be supplied with an artificial positive charge, an equivalent negative charge will be induced upon the interior surface, and *vice versa*. Moreover, say the advocates of the theory, if the natural charge was one in which the outside of the sheath was positive, it was to be supposed that the communication of positive electricity to the outside would be favourable to the irritability of the nerve and muscle, and that the opposite charge of negative electricity would be less favourable. At a future time we hope to detail some of the experiments by which the theory has found support in practice. The results have shown that static electricity is as effectual in its action as voltaic electricity, and that the latter developes irritability not by its current so much as by the charge associated with this current. Of course the charge may be made positive or negative by putting the opposite

pole of the battery to "earth." When the body, sufficiently insulated, is placed in the circuit, it may entirely be charged with positive or negative electricity by putting the one or the other pole of the battery into connection with earth; and the conditions are favourable to irritability in the former, and unfavourable in the latter case. For a voltaic battery may be substituted a frictional machine, the object being, as we have iterated, to charge the sheaths positively as they are charged naturally.

For a more definite statement of the law than can be included in the pages of a journal we must refer the reader to Dr. Radcliffe's account of his experiments, in his work entitled "The Dynamics of Nerve and Muscle." We hope that the time will not be far distant when the general practitioner will be able to derive sufficient advantage from this theory, so universal in its way, and render the "positive charge" an important therapeutical agent.

Correspondence.

ON THE RELATIONS OF LIGHT AND ELECTRICAL CONDUCTIVITY.

To the Editor of the Telegraphic Journal.

SIR,—Will you permit me to record in your columns that the subject indicated above, and referred to in the *Telegraphic Journal* for February 15,* was experimented upon by myself some years ago, and that in conjunction with my friend and colleague, the late Mr. Frank L. Fowler, some very remarkable results were obtained.

We experimented upon both good and comparatively bad conductors, during leisure and intermittent periods, for a space of nearly eighteen months, and these researches were to have been resumed upon a more comprehensive plan, the outline of which had already been sketched out by us; Mr. Fowler's premature and unlooked for demise, however, cut short the enquiry, and for a long time imbued me with a disinclination to proceed with this and the researches we had previously studied together.

One most important application of these phenomena I hope to develop further during the next year or so, and may trouble you with some of the results in a tabular form perhaps before long.

I gather from your notice of Mr. Smith's paper that this gentleman is of opinion that *temperature* exerts no influence whatever upon the phenomena in question; at the moment I will content myself with the remark that the experience of Mr. Fowler and myself did not lead us to a similar conclusion.—I am, &c.

WENTWORTH G. SCOTT.

Analytical Laboratories, Wolverhampton,
March 17, 1873.

RESISTANCE OF GALVANOMETERS.

To the Editor of the Telegraphic Journal.

SIR,—Referring to the article in your last number by M. Th. Du Moncel, "On the Conditions of the Maximum Resistance of Galvanometers," does it not appear that the author has misunderstood the nature of the law that "for a galvanometer to attain the best possible conditions of sensibility with regard to a circuit of given resistance, it is necessary that the resistance of the magnetising helix should equal that of the exterior circuit with which it is put in connection." Unless I am greatly mistaken, it means, that if a given space is to be filled with wire, the diameter of that wire should be so chosen as to make its resistance equal to the exterior resistance (disregarding a correction necessary in certain cases, caused by the constant thickness of the insulating covering—which correction Schwendler has given). Now M. Th. Du Moncel appears to have taken wire of a *constant* diameter, and *not* to have preserved the space occupied by that wire constant. In fact he makes g^2 constant, and a the variable. This is of course an entirely different thing.—I am, &c.

OLIVER HEAVISIDE.

Newcastle-on-Tyne,
March 23, 1873.

* Communication from Mr. Willoughby Smith to the Society of Telegraph Engineers.

SOCIETY OF TELEGRAPH ENGINEERS.

To the Editor of the Telegraphic Journal.

SIR,—I have heard from good authority that a lady telegraphist has applied for admission as an Associate of the Society of Telegraph Engineers, and has been rejected by the Council. I want to ask you, have or have not female operators a right to be admitted as partakers of the benefits of instruction conveyed through the lectures and papers of the society?

There are in London about 500 male telegraph clerks, and 500 female operators; therefore, as the ladies form 50 per cent of the whole, ought they to be excluded entering?

The Royal Institution of Great Britain and the Society of Arts admit lady members, the Astronomical Society has also, to my knowledge, in one instance done the same; are they less respectable than the Society of Telegraph Engineers?

Does the fact that male operators receive 26s. a week, and female only [*Qy.*, ED.] 13s., render the latter ineligible for election?

I don't want to see female operators either on the Council or in the President's chair, but if they want to sit and listen, and learn, I can only say that it is in my humble opinion an instance of illiberality on the part of the Council to prevent them. And, further, I believe that if the question were put to the vote, as it ought to be, the general voice of the members would be in favour of the extending the advantages of this society (which seems even in its extreme youth to be getting very conservative) to not only all respectable classes of male telegraphists, but to all those female operators whom Mr. Scudamore and Mr. Culley consider respectable enough to become, under their direction, Her Majesty's servants.—I am, &c.

ASSOCIATE OF SOCIETY OF TELEGRAPH ENGINEERS.

Two courses of instruction for naval officers in electricity and torpedo management will be held this year on board the *Vernon* at Portsmouth. The first course commenced on the 1st of April, and the second will be on the 25th of July; each course will last about two months.

FREE MESSAGES. — The directors of the Atlantic Telegraph Company have granted free passage to messages conveying intelligence of discoveries in astronomical science which the authorities of the Smithsonian Institute may desire to communicate to the authorities of the European observatories, and *vice versâ*. Professor Henry is entitled to the thanks of astronomers for his successful efforts to secure this boon. It is to be hoped that the local lines in the various countries will also remit the fees, so as to make the interchange of important information completely free.

Electrical Science in Foreign Journals.

(We intend to devote this column to a list of Electrical Memoirs published in Foreign Journals during the month. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxvi., No. 9.

Action of the Electric Current on a Mixture of Equal Volumes of Carbonic Acid and of Protocarbide of Hydrogen.—By MM. P. and Arn. Thenard. The gas known as marsh-gas is essentially a mixture of protocarbide of hydrogen and carbonic acid. The exact relation of the two gases is without doubt variable. but may be taken as nearly in the same proportion. But if we consider the subject, we arrive at the constitution of an organic molecule often found in the products of vegetation. But how do these elements unite when dissociated by putrefaction? Last year one of us perceived that carbonic acid under certain disadvantageous actions of the electric current, separated into carbonic oxide and oxygen, and that the oxygen had a tendency to ozonification, that is to say, to a state favouraale to its spontaneous combination with numerous oxidisable bodies. Protocarbide of hydrogen is one of these bodies. To a tube placed horizontally on a support there were attached two little reservoirs of 12 c.c., the inferior opening being plunged in a bath of mercury; the air contained in the reservoirs, and the canal uniting them, being driven out by a mixture of equal volumes of carbonic acid and of protocarbide of hydrogen, we pass the current. At the end of ten minutes, and without any appearance of dilation, the condensation of the gas is sensible, and at the end of six hours it was complete. As to the product, it is a very limpid, viscous liquid. As a counter test we have submitted the same gaseous mixture to the electric spark. Then the phenomena are diametrically opposed; the gases are dilated, and at the end of an hour, operating with 60 c.c., their volume had varied from 2 to 3·5 volumes, and at the same time a quantity of carbon was deposited, proving the decomposition of the protocarbide, and the non-formation of carbonic oxide. The action of the spark then differs entirely in this experiment from that of the current; the one destroys, and the other reconstructs. M. Dumas, who has verified the experiment, says that in this light electricity appears as a new chemical force.

M. E. Solway submits to the judgment of the Academy a memoir concerning the production of electricity in the act of the vesicular condensation of the vapour of water, and the principal consequences of this fact. The memoir is in five divisions, in which the author treats specially:—(1). Of the electrolysis of water by the simple fac tof the vesicular condensation of the vapour; (2). Of the theory of steam-boiler explosions, and the means of prevention; (3.) Of the theory of the atmospheric production of ozone; (4). Of the general theory of the principal electric phenomena of the atmosphere; (5). Of the general theory of terrestrial magnetism, polar aurora, &c.

No. 10.

On the Production of Electric Currents, and on their Mode of Action.—By M. A. Boillot.—I have had the honour to inform the Academy that I had employed carbon with success in the construction of electrical apparatus, and I have to-day to describe some further new apparatus. I have taken three glass tubes, of 3 m.m. interior diameter by 35 c.m. in length. This tube is filled with retort-carbon in powder, and is sealed before the lamp at its two extremities, into one of which passes a platinum wire communicating with the carbon. The small tube thus filled is introduced into another tube of 8 m.m. diameter, and this into a tube of 12 m.m. diameter. The annular space between the large tube and the middle tube is filled with powdered retort-carbon; a second platinum wire, opposed to the first, communicates with the carbon. In putting one of the platinum wires in connection with one of the poles of an induction-coil, and the other wire with the other pole of the coil (which is worked by a few Bunsen elements), we develope an electric current,—that is to say, there are no sparks, the current traversing the sides of the two tubes. By filling the tubes with oxygen I have succeeded in preparing 50 milligrammes of ozone per litre of gas employed. The experiments I have made, independently of the preparation of ozone, are three in number:—In the first I have developed, in the middle tube, vapour of sulphur in contact with oxygen, without the intervention of electricity, and also with the intervention of the electric fluid. In the first case, the sulphurous acid product was accompanied by a little sulphuric acid; and in the second case, the quantity of sulphuric acid was very considerable. In the second experiment I have still worked with vapour of sulphur, but the gas introduced into the apparatus was dry hydrogen. As long as electricity is not called into action, the hydrogen and the vapour of sulphur remain without action the one on the other; but with the intervention of the current, sulphuretted hydrogen immediately appears. I have already had occasion to inform the Academy that I had failed to produce the synthesis of sulphuretted hydrogen by means of electric sparks acting upon sulphur in an atmosphere of hydrogen; but here the manifestation of electricity is different. Finally, in the third experiment, I wished to study the result that would be furnished by a mixture of cyanogen and hydrogen; the result I hope to submit to the Academy at an early date.

Les Mondes. Vol. xxx., No. 12.

Electricity and Light.—A note upon the recent discovery made by Mr. Willoughby Smith with bars of selenium.

Exposé des Applications de l'Electricité.—This is the title of the second volume of M. du Moncel's work, reviewed in the present number. The review says—"We have remarked with pleasure the care with which the author has elucidated certain embarrassed questions with regard to the machines of Gramme and of Holtz, the contradictory effects obtained with electromagnets, the origin of accidental currents developed in telegraph lines, &c." The third and fourth sections are the most important. The third deals with test-instruments as divided into four grand classes:—Instruments for measuring electric currents, resistances, tensions, and calorific effects. The fourth section includes the consideration of the relation of circuits and their organisation. It is divided into three chapters, treating, the first, of circuits imperfectly insulated, such as local circuits and aërial lines; the second, of circuits perfectly insulated, such as submarine cables; the third, accidental currents developed in lines, and the means for avoiding their effects.

On the Production of Electric Currents, and their Mode of Action.—Note from M. A. Boillot, communicated to the Academy of Sciences.

Revue Scientifique. No. 37, 2nd series.

Influence of Solar Electricity on the Barometric State.—By M. Hornstein.—The idea of this influence first occurred to Lamont, who, thirty years ago, endeavoured to explain the diurnal variations of terrestrial magnetism, and, in part, that of the barometer by solar electricity. The author finds confirmation of Lamont's ideas in the tables of observations forwarded to the

Academy of Sciences of Vienna, whence he endeavours to establish a relation between the barometric maxima and minima, polarised light, and spots on the sun.

Journal Telegraphique. Vol. ii., No. 14.

General Statistics of Telegraphy for 1871.—A valuable paper.

Study of the Synchronism of the Hughes' Apparatus.—A purely mechanical essay, but of much interest.

American Journal of Science and Arts. Vol. v., No. 27.

Observations on the Duration and Multiple Character of Lightning Flashes.—By Prof. O. N. Rood.—Arago classifies the different forms of lightning under three heads; and Prof. Rood describes some experiments with regard to the nature of these three kinds, and with regard to their spectra.

Patents.

2483. B. Hunt, London. *Physiological, or "button" battery.* Dated 21st August, 1872. This invention consists in adjusting buttons or discs of copper or silver, and of zinc or alloy (or their equivalent, in dissimilar metals), upon a flexible insulation as a base, with metallic connections upon the back, the whole being arranged and constructed so that the battery is made pliant and durable, and capable of being worn on any uneven surface of the body or limbs.

2547. H. Highton, Putney. *Electric cables.* Dated 27th August, 1872. According to this provisional specification the insulated core of the cable is coated with boiled oil and red lead, and over this when the coating is dry the outer strands of the cable are laid.

2587. W. R. Lake, London. *Lighting gas and other burners.* Dated 30th August, 1872. This invention relates to that class of electrical apparatus for lighting lamps in which the current is successively thrown into the magnets at all of the burners one after another. The circuit-breaker is located at the burner, and by the direct action of the current through the magnet located at the burner the circuit-breaker and the valve for admitting or turning off the gas are both operated, and the circuit after the opening or closing of the valve at one burner is completed, cut off from the magnet of such burner, and thrown into the magnet of the next burner, and so on.

2592. W. H. Samuel, Liverpool. *Lighting gas by electricity.* Dated 31st August, 1872. This invention relates to apparatus for developing electricity to be used in lighting gas, and it consists in the employment of a burner in such connection with the frictional generator that the gas must pass through the latter to the burner, whereby the apparatus is made applicable to a gas pipe, droplight, bracket, stand, chandelier, or other analogous fixture to which a common burner may be secured. The invention further consists in mounting the upper section of the electro-generator upon a hollow sleeve in such manner as to inclose the tube of the burner, and have an axial as well as a partial rotary movement upon said burner for the purpose of generating the electricity without interfering with the position of the burner or the fixed plate of the generator. The invention further consists in the arrangement of the means by which the electro-generator is operated immediately beneath the same in connection with a slotted tube, in such a manner as to allow one of the plates to have a limited axial and rotary movement, and afford facility for catching hold of it without interfering with the burner, the shade, globe, or the movement of the plate to liberate the electricity.

786. W. Grigg, Tamerton Foliott, Devonshire. *Electricity to horses and cattle.* Dated March 5, 1873. The invention consists in applying electricity for the treatment of horses and cattle suffering from disease, the same being effected by fastening on different parts of the animal certain metal pieces, which are connected to a machine generating electricity, one or more of the metal pieces acting as positive, and others as negative, thus sending a current of electricity through the animal, and thereby producing beneficial effects.

2702. G. A. A. Cunningham and T. P. C. Cunningham, Liverpool. *Electro-magnetic motors.* Dated September 12, 1872. This relates to the construction of electro-magnets, and the disposition of armatures and magnets with relation to each other. Magnets are each built up of a series of primary and secondary metal bars or wires insulated from each other, and also insulated together. The armatures and magnets are so disposed in relation to each other that a continuous rotary motion is obtained whilst practically uniform power is being transmitted.

2739. W. Morgan-Brown, London. *Telegraph apparatus.* A communication. Dated September 14, 1872. This invention relates to improvements in telegraph apparatus. The escapement being arranged so as to give a regular and positive step-by-step motion to the printing wheel. To a printing magnet and levers operated by a switch current. To devices for feeding the strip. To a printing pad composed of cork, and to devices for securing unison.

861. W. C. Barney, London. *Electric telegraphs.* Dated March 10, 1873. The claim to this complete specification is the combined arrangement of electric telegraphs substantially as herein described. Arrangements are described by which the evils arising from induction are avoided, and distant signals can be transmitted with accuracy; arrangements also for saving time in repeating messages as described.

UNITED STATES.

3344. J. B. Stearns, Suffolk, Massachusetts, U. S. A., *Electric Telegraphs.*—Dated November 11, 1872. 1. Certain improved modes of constructing the electro-magnets for receiving instruments, by means of which the effect of the outgoing electric currents upon the armature of the said electro-magnet or magnets are more perfectly neutralised. 2. An improved arrangement of the rehostats or artificial resistances in combination with the circuit breaker, by means of which the resistance opposed to the battery at each station is always practically the same, whatever may be the position of the apparatus at the opposite station. 3. An improved mode of constructing and operating the circuit beaker or key which transmits the electric currents upon the main line. 4. The application of a condenser or other equivalent device to the apparatus, by means of which the effect of static induction in operating either land lines or submarine cables is neutralised or compensated for. 5. The manner of placing a relay or other receiving instrument in the circuit of a bridge wire, so that said relay or other receiving instrument will be operated by received currents and not by transmitted currents. 6. A repeater or translator for use in telegraphic apparatus for double transmission. 7. An arrangement of circuits whereby one or more branch offices are enabled to operate the transmitting key or circuit breaker at the main office, and also whereby the receiving relay at the main office is caused to operate a receiving instrument at said branch office or offices, for the purpose of establishing direct communication between branch offices in one place and the main office

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	March 22nd.	March 29th.	April 5th.	April 10th.
£		£				
Stock	Anglo-American (Limited)	100	152 157	165 172	157 162	155 160
10	British Australian (Limited)	All	9⅞ 10¼	9⅞ 10¼	10¼ 10⅝	10¼ 10⅝
10	British Indian Extension (Limited) ..	All	14 14½	14 14½	14½ 14¾	14½ 14¾
10	China Submarine (Limited)	All	10 10¼	10 10¼	10⅜ 10½	10⅜ 10½
10	Cuba (Limited)....	All	10 10¼	10 10¼	10¼ 10¼	10 10¼
10	Eastern (Limited)	All	9⅞ 10 xd	9⅞ 10¼	10 10¼	9⅞ 10¼
10	Great Northern	All	11½ 11⅝	11 11⅛	11 11⅛	11 11⅛
20	Great Western (Limited)	13	3½ 2½ dis	3½ 2½ dis	3½ 2½ dis	4 3 dis
20	Hooper's Telegraph Works	All	11½ 12½	11½ 12	11½ 11⅝	— —
50	India-Rubber, Gut. Per., and Teleg. Works	45	36 37	36 37	35 37	— —
25	Indo-European (Limited)	All	15 17	16 18	16 18	16 18
10	Mediterranean Extension (Limited) ..	All	6 6½ xd	6 6½	6 6½	6 6½
—	Ditto 8 per cent Preference ..	—	— —	— —	— —	— —
—	New York, Newfoundland, and London	—	— —	— —	— —	— —
10	Panama and South Pacific (Limited)	2½	— —	— —	— —	— —
8	Reuter's (Limited)	All	10½ 11½	10½ 11½	10½ 11½	10½ 11½
20	Soc. Transatlant. Fran. (Limited)	All	31½ 31¾	34 35	34¼ 35	33¼ 34
20	Ditto New	15	26½ 27	— —	— —	— —
Stock	Submarine	100	225 230	220 230	220 230	225 230
1	Ditto Scrip	All	2⅛ 2⅜	2 2¼	2 2¼	2 2¼
—	Submarine Cables Trust	—	— —	— —	— —	— —
12	Telegrph. Construction and Maintenance	All	30½ 31	30½ 31	30½ 30⅞	— —
10	West India and Panama (Limited) ..	All	8 8¼	8⅛ 8⅜	8⅛ 8⅜	7⅞ 8⅛
—	West Un. U.S. 7 per cent 1st M.B. ..	—	— —	— —	— —	— —

or branch offices in one or more places, or *vice versa*. 8. An arrangement of telegraphic apparatus whereby way stations are enabled to communicate with either or both terminal stations employing duplex instruments or double transmitters.

134,776. *Repeater for Duplex Telegraphs.* Joseph B. Stearns, Boston, Mass. Pulsations from line east cause armature of A to close local circuit through B', which closes main circuit to west line; A' in that circuit being a "duplex magnet," is unaffected thereby. Pulsations from line west operate A', B, and line east similarly. A or A' is affected only by a current from its line side. The arrangement, in a duplex repeater, of the electro-magnets A A' B B', and their corresponding circuits, as and for the purpose set forth.

133,866. *Printing Telegraph Instrument.* Thomas A. Edison, Newark. N.J. In an instrument when the type-wheel is arrested by a pin on its shaft coming in contact with a depressed key, and the pulsations are sent by a revolving motor or pulsator, the pulsator is stopped when the type-wheel is stopped by a lever attached to the escapement armature lever coming in contact with a pin on pulsator shaft.

134,867. *Automatic Telegraph Instrument.* Thomas A. Edison, Newark, N.J. Neutralises any earth or extra currents in automatic instruments by a weak constant local circuit, preventing "tailings" and blurs in the writing, and the stylus being destroyed while inactive.

The New Atlantic Cable.—The Great Eastern, lying in the Medway, has received on board the whole of the deep-sea section of the new French Atlantic cable. As our readers are aware, four cables have already been laid, three of them being in successful operation at the present time. The first of these three, laid and broken in 1865, picked up and completed in 1866, and the second, laid in 1866, from Valentia to Newfoundland, belong to the Atlantic Telegraph Company and to the Anglo-American Telegraph Company. The third, laid in 1868, from Brest to New York, belongs to the company laying the new cable, the Société du Cable Transatlantique Francais. The immersion will be effected in the last days of May and the beginning of June, the great ship leaving her moorings on the 20th May. The point of departure is the same as that of the Indian cable—a place called Germoe, on the north side of Mount's Bay, Cornwall. It had been intended to start from Whitesand Bay, on the western side of the Land's End peninsula, but the shore end would there have been liable to injury, as many coasting vessels bring up in that bay during easterly winds. This part of Mount's Bay is sheltered from all the heaviest seas, and is, indeed, protected from twenty-five points of the compass, the remaining seven covering an area in which no great run of sea can be got up, however heavy the gale. Forty fathoms of water is reached in about 4 miles, and the shore end for this, although the landing-place is so protected, will be much heavier than those put down at Foilhommerum Bay, where the sea plays with boulders the size of a cottage, and where, nevertheless, the shore end, laid in 1865, is still intact. The descent into the thousand fathom bottom is much less abrupt from the chops of the Channel than off the coast of Kerry; and there is no deeper water all the way across on this track than on that of the cables of 1865 and 1866. The cable carried by the "Great Eastern" will be landed at Freshwater Cove, in Halifax harbour, on a piece of land in the occupation of the War Office, by which leave to use the Cove has been granted. There will then be laid a branch cable from Freshwater Cove to Hog Island, near the end of Long Island, and only 15 miles from Sandy Hook, nor much more from Brooklyn. Thus not only shall we have a cable from Cornwall to Halifax, and that is much in a military point of view, but there will be obviated the danger of a delay in commercial messages over Newfoundland. The Halifax to Hog Island section and the shore ends will be conveyed in three vessels—the Hibernia, of 2000 tons; the Edinburgh, of 3000 tons; and the La Plata, of about 1800 tons; and if nothing goes wrong the fourth cable will be working to New York by the 20th of June next. The new cable differs somewhat from any of those hitherto laid, either to America or elsewhere. There are seven No. 18 gauge copper wires, twisted in a spiral, and weighing 300 lbs. per nautical mile, and these are covered with four coats of gutta-percha, with thin layers of Chatterton's compound, this amounting to 400 lbs. per knot. The diameter of the strand is 0·146 inch, and of the wire and gutta-percha and compound 0·0464 inch. This core is served with hemp, and the hemp is again protected by ten wires drawn from homogeneous iron, each wire being swathed in five yarns of Manilla hemp laid on spirally, with a tarry compound to preserve it. So far the cable is not dissimilar to those of 1865 and 1866, and is almost identical with that of the French cable of 1868, but it is sensibly larger, and the difference is owing to twe servings of jute yarn wound on in contrary directions, and covered with two coats of

Latimer Clark's preservative compound. The cable weighs nearly 2 cwts. per knot more than the previous cables, but it is even stronger in proportion, and is calculated to last at least twice as long under the same conditions.

A New Battery.—M. H. Cauderay, of Lausanne, describes the construction of a small, portable, and economical galvanic battery, which, he says, will be particularly useful for purposes of military telegraphy. Its fundamental part will certainly be peculiarly accessible to military men, for the cells, which serve at the same time as the positive electromotors, consist of the used copper cases of rifle cartridges. These are scraped clean, and arranged in holes made in a small board. They are then charged with a layer of about half an inch of pounded and moistened sulphate of copper, and filled up nearly to the top with sawdust soaked in pute water. The negative electromotor is a small cylinder of zinc, about an eighth of an inch thick, which is passed down into the sawdust through a hole in a varnished cork, closing the aperture of the cell. A small notch must be made in one side of the cork to allow of the escape of gas. Of course the copper cell and the zinc cylinder must have wires attached to them, for the purpose of attaching them to the opposite poles of the neighbouring cells. A battery of twenty such cells, exhibited by M. Cauderay to the Society of Sciences at Lausanne, sufficed to work a portable military telegraph against a resistance of 4000 Siemens units. The knowledge of so cheap a form of battery will be welcome to many who like to amuse themselves with experiments in galvanism.

New Magneto-Electric Machine.—We have had an opportunity of witnessing the trial of a Gramme's magneto-electric machine, which appears to be likely to give satisfactory results. Messrs. Whieldon and Clarke, of Westminster Bridge Road, at whose works it now stands, are engaged in building a larger machine on the same principle. It will be remembered that in Wilde's machine the large electro-magnets were excited by an induced current derived from a row of small steel magnets, between which worked a Siemens armature. The present machine dispenses with the permanent magnets, the induced currents being made to circulate round the soft iron magnets which produced them. To Siemens and Wheatstone is due the proposal that such a machine should be constructed. Iron has usually some traces of permanent magnetism, especially if it has once been magnetised, and this magnetism is sufficient to induce feeble currents in a revolving armature. These currents are sent round the iron magnet, thus increasing its magnetisation. Ladd also constructed a machine which embodied the principle. By the rotation of one Siemens armature, he obtained an induced current from a soft iron magnet, which he in turn further excited by the induced current. A second Siemens armature then collected the indirect current from the other end of the magnet for use. The machine—at the trial of which we were present—consists of a row of modified horseshoe electro-magnets, surmounted by another row of inverted similar electro-magnets, the poles consequently being face to face, but of course separated by a space. In the central space there revolves a drum carrying the armatures, one armature being supplied to every pair of magnets. The armatures are simply rings or hoops of soft iron, surrounded by a number of helices containing wire. The ends of the wire of each helix are brought down to the shaft of the drum, each insulated from the other, and thence the currents are collected in the usual way. Pieces of iron attached to the poles of the magnets partly embrace without touching the armatures. In the machine in question there were three armatures, one of which was sufficient to excite all the magnets by means of the induced current, as above described, and the other two were sufficient to provide a powerful current, which gave an excellent light. The power required to drive the machine was about 3½ or 4-horse.

The Folly of Bad Penmanship.—The folly of bad writing is never better exemplified than in a telegraph office. A man rushes in, throws down a message, scrawled and blurred. It is important that that message should be sent instantly; at least ten thousand dollars are depending upon a speedy answer. The operator seizes it, and whisks away to call "Pittsburg." In less than a minute he is sending the message—three seconds he is "stuck," and he cannot for the life of him make out the next word. Forthwith the messenger boy is sent to the office of the sender (a half dozen blocks away) to find out what the obscure word is. The sender is not in—his clerk does not know what the word should be, it being a cipher message. Twenty minutes' fruitless search in the Stock Board, Gold Room, and other places where merchants and brokers "most do congregate," brings the messenger back to the telegraph office just as the sender comes in for his answer, only to be told that his message has not been sent yet. No one is to blame but himself, and his well-known habits indicate that the adoption of the proverb, "The more haste the less speed," will be but transient.—*American Newspaper Reporter.*

At the meeting of the Society of Telegraph Engineers, held on the 9th inst., a paper was read by Mr. Wm. F. King, "On a Bell Alarm for Submarine Cables." This was followed by a paper by Mr. R. S. Culley, "On the Mechanical Tests of Iron Wire." At the next meeting papers will be read by Mr. W. H. Preece and Captain Mallock, "On the Block System of Working Railways."

Errata.—Page 61, Equation (4)—

$$For\ \frac{n\sqrt{\frac{r}{Re}}}{2rn}\ \ read\ \frac{n\sqrt{\frac{r}{R}e}}{2rn}$$

And $$for\ \frac{\sqrt{\frac{r}{R}}}{2r}\ \ read\ \frac{\sqrt{\frac{r}{R}e}}{2r}$$

Page 62, Equation (9)—

$$For\ d=2\sqrt{\frac{\gamma lm}{2Gc}}-s.\ \ read\ d=2\sqrt[4]{\frac{\gamma lm}{2Gc}}-s.$$

Societies' Meetings for the Month.

Meteorological Society.—Ordinary Meeting and Council Meeting, April 16, at 6 and 7 p.m.
Geological Society.—April 30.—May 14. At 8 p.m.
The Society of Telegraph Engineers.—April 23.—May 14. At 7.30 p.m.

To Correspondents.

W. Coleman, Boston.—Van Nostrand, New York.
M. T. and Electro.—Received with thanks.

BOOKS RECEIVED.

"A Treatise on Electricity and Magnetism." By James Clerk Maxwell, M.A., LL.D., F.R.S., 2 vols. London: Macmillan and Co. 1873.
"Modern Practice of the Electric Telegraph." By Frank L. Pope. Seventh Edition. New York: D. Van Nostrand. 1872.
"Our Schools and Colleges." By F. S. Carteret-Bisson, F.R.G.S.
"Catalogue of Scientific, Naval, and Military Books." New York: D. Van Nostrand. 1873.
"Letters Patent, their Cost and Charges." London: Brooman and Co. 1873.